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PATENT

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***IN THE UNITED STATES PATENT AND TRADEMARK OFFICE***

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In re application of: Bailey III et al.

Attorney Docket No.: LAM1P123/P0557

Application No.: 09/470,236

Examiner: Alejandro Mulero, Luz L.

Filed: November 15, 1999

Group: 1763

Title: PLASMA PROCESSING SYSTEM WITH  
DYNAMIC GAS DISTRIBUTION CONTROL

Confirmation No. 5922

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**CERTIFICATE OF FACSIMILE TRANSMISSION**

I hereby certify that this correspondence is being transmitted by facsimile to fax number 571-273-8300 to the U.S. Patent and Trademark Office on June 9, 2006.

Signed: \_\_\_\_\_

  
Carol Diez

**PRE-APPEAL BRIEF REQUEST FOR REVIEW**

Mail Stop AF  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

Applicant requests review of the final rejection in the above-identified application. No amendments are being filed with this request.

This request is being filed with a Notice of Appeal.

The review is requested for the reasons stated on the attached sheets.

Remarks begin on page 2 of this paper.

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09/470,236

**Examiner Failed to Show Teachings for Several Claim Limitations and Sufficient  
Motivation to Modify such Teachings**

The Examiner rejected all the claims under 35 U.S.C. 103(a) using various combinations of at least 10 references (over 36 different combinations). Mainly, the Examiner used Li, Li, Collins, and Muregesh as primary references in combination with Fujii, Fujiyama and Yamazaki as secondary references.

With regards to all the references, the Examiner asserted that it would have been obvious to one having ordinary skill in the art at the time of the invention was made to modify the apparatus of (Li, Li, Collins, or Muregesh) to comprise the claimed gas inlet structure, because in such a way the same gas (or mixture of gases) can be introduced to the chamber through the different regions (Fujii, Fujiyama, Yamazaki).

As stated throughout prosecution, however, a prima facie case of obvious has not been made. The Examiner simply has not provided a reason as to why one skilled in the art would modify the cited references to come up with the claimed invention.

The Examiner only relies on individual parts taught in the various references. It should be noted, however, that although every element of a claimed invention may often be found in the prior art, the identification in the prior art of each individual part claimed is insufficient to defeat patentability of the whole claimed invention.

To elaborate, each of the cited references discloses a gas system that should be taken in totality. Pieces should not be taken from one and added to another. Each of these systems is a system and therefore the addition of another element would surely effect the proper functioning of the system in a non-trivial manner. One skilled in the art would simply not be motivated to combine the teachings of the various components of these systems to come up with the claimed invention. Furthermore, it is believed that the motivation to combine should come from something other than the fact that these are gas systems since each of these gas systems operates in a substantially different manner. Simply put, there is no teaching or suggestion that one should use these gas systems, out of countless gas systems, as a gas system for use in another gas system.

To further strengthen this position, it is pointed out that unlike the present invention which is directed at etching, a majority of the cited references including primary references and the secondary references are directed at deposition (e.g., Li (551), Muregesh, Fujii, Yamazaki, Fujiyama). Etching and deposition are two distinctly different processes with different requirements. Pieces from a gas flow system associated with deposition cannot simply be added or combined to a gas flow system associated with etching without some modification (which has not been adequately supplied). While the cited references may show gas flow systems, they are from a different world of processing where specific gases being used for deposition were known to be highly reactive on the wafer and hence of critical importance by themselves on the resulting performance of the deposition process. This is why you see the prevalence of different gas mixtures introduced at different locations in the chamber. For instance when the depositing gas needs to be ionized or disassociated by the plasma in order to essentially stick and react on the wafer in one bounce, you find multiple gas locations for gas feeds especially split near and far from the wafer or plasma source. This is very different from the present invention, which includes top center and edge (top and/or bottom) arrangements with a single gas mixture.

Moreover, at the time of the invention it was not at all obvious that an etch process that depended on plasma etch processes producing volatile products from the wafer would benefit from dual location gas feeds of the same gas mixture but in varying flow quantities. This lack of obviousness was due to the lack of sensitivity of the then current device geometries and resulting etch profiles and rates to variations in gas flows relative to variations in plasma controlling parameters such as pressure and rf power. The low pressures used for plasma etch, form non-

plasma gas mixtures that do not interact strongly with the wafer or chamber walls, hence the neutral gas bounces all over the chamber to equalize the pressure near instantaneously from wherever it is introduced in the chamber. Thus, the plasma resulting from the various flow ratio in the present invention are nearly identical and yet process uniformity control can still be had. At the time though, the conventional wisdom was that it really didn't matter that much where you introduced reactive gasses to the etch chamber, especially if you weren't going to change the gas mixture. What mattered much more was how and where you supplied power into the plasma and how these charged and excited species diffused to the wafer. This was especially true in plasma etch systems where the electrical forces on the charged species that were most involved in driving the etch process results where a much stronger influence on the uniformity of the plasma and hence the plasma etch results than the neutral dynamics. You can see this concern even in the antenna design, magnetic uniformity control and plasma density control patents that are incorporated by referenced in this application. It was the inventors realization that for advanced etch uniformity control both electromagnetic control of the plasma as well as addition of the subtle gas distribution control would be required and important in the future which drove the invention. Please also see all of page 14 of Amendment G filed on 7/22/05 for additional details.

In summary, the present invention is part of a group of applications (all of which are incorporated by reference) directed at azimuthally symmetric processing. It is believed that azimuthally symmetric processing provides better control and more uniform processing at the surface of the substrate. With regard to the present invention described herein, a gas flow system is configured to carry and distribute the same gas mixture (from the same source) to different outlets, and to control the amount of gas through each of the outlets. The invention allows a set single gas mixture with a single sum total flow (sccm) to be split or rationized to multiple portions of the chamber. By rationizing the gas at different regions, the gas may be distributed more evenly inside the process chamber (which as a result can produce more uniform results across the surface of the substrate). Furthermore, the gas mixture being delivered to each region is the same (e.g., from the same source) thereby reducing variations caused by delivering a different gas mixture to each of the regions. It should be noted that even if two independent gas supplies used the same recipe to produce the same gas mixture, there would be differences in the outputted gas mixture (different independent gas sources cannot make exactly the same gas). These differences lead to process variations. Further still, the gas being delivered to each region is symmetrically distributed in each region. For example, a gas ring having a series of holes substantially equidistant about the periphery of the ring or a gas distribution plate with symmetrically patterned holes can be used.

This is not the case in the cited references. In the cited references, different gases are fed individually into different portions of the chamber and in some cases the gases are only fed into one region of the chamber. As a result, process variations may be produced during processing. Furthermore, their systems are much more complex and likely to send too much gas (or are actually set to prevent the ability to send too) a single gas outlet. Their systems are set to prevent mixing or they have independent controls so their gas mixture setting MFCs are all driven independently with reasonable pressure drops across them. If they put all their flows together, their MFCs would have very little pressure drop across them and fail to control and hence lead to failure to control the mixture of the total flow. Moreover, the references do not describe azimuthally symmetric distribution of gases.

With regards to the primary references, *Li* (6070551) feeds multiple gases individually and is all about being able to deliver different mixtures. In contrast, the present invention feeds a single mixture thereby always ensuring the same mixture is fed to the different regions. *Muregesh* (6228781) is all about delivering different gases, purging, managing cleaning, etc. They have many flow controllers 35A-A', 35B-B', etc. that go to multiple areas thereby making it very difficult to perform key element of the present invention, i.e., adjusting the gas ratio with

a sure identical single mixture. *Collins* (6024826) teaches seven independent gas supplies, which is very complex and difficult to control. In contrast, the present invention feeds a single mixture thereby always ensuring the same mixture is fed to the different regions. In addition, *Collins* does not teach rationing to different regions. *Li* (6009830) mixes gas inside delivery lines and needs to set individual flows into the delivery lines to set ratio. Mixture and sub-total flow set by 68/72 goes to 56-54 while user must independently specify another mixture and total flow set by 70/74 going to 52/38 to ensure ratio of same mix with sum total gas delivered. In contrast, the present invention makes it easy to use a standard gas box with a bunch of MFCs to set a single gas mixture with a single sum total flow (sccm) that is then split by setting a single ratio to two different portions of the chamber.

With regard to the secondary references, *Fujii* does not deliver the same gas to two different regions. *Fujii* only delivers gas to a top region. Furthermore, the pipes are not azimuthally symmetric, but rather inline (see Fig. 7). *Fujiyama* discloses gas emitting tube 4 and gas emitting ring 9 that emit different gases at different times and thus the flow of a single gas is not controlled or rationized to two different regions. *Yamakazi* does not deliver gas to two different regions, and further does not control or rationize the exiting gases. In all three references, azimuthal symmetry is not described.

The remaining discussion is directed at independent claims 1, 19 and 50. It should be appreciated that similar arguments can be made against the rejections to the other independent claims 69 and 70.

#### Claim 1

In contrast to *Li*(830), *Li* (551), *Collins*, *Muregesh*, *Fujii*, *Fujiyama*, *Yamakazi* claim 1 (and its dependents) specifically requires, "said gas flow system controlling flow of a single input gas comprising a mixture of etchant source gases into at least two different regions of said plasma processing chamber....at least a first portion of said input gas being delivered to said plasma processing chamber via said first outlet and a remaining portion of said input gas being delivered to said plasma processing chamber via said second outlet." The primary references *Li* (830), *Li* (551), *Collins*, *Muregesh* do not disclose this limitation thus the Examiner relies on support from the other references *Fujii*, *Fujiyama* and *Yamakazi*. These references, however, also fail to teach or suggest such a limitation.

In *Fujii*, the four vent pipes 111-114 are only located at the top of the reactor chamber 5 and thus gases are not delivered to two different regions. That is, they only deliver to a top region. It should be pointed out that as further required by claim 1 the two different regions include at least a peripheral region and a top region. A peripheral region is simply not taught in *Fujii*. In *Fujiyama*, the gas emitting tube 4 and gas emitting ring 9 emit different gases and thus the flow of a single gas is not controlled to two different regions. As stated in *Fujiyama*, "silane gas from a starting gas tank 7 is emitted through a starting gas emitting tube 4 into the reaction chamber (Col. 2, lines 43-45)...a gas mixture of carbon tetrafluoride and oxygen in gas mixture container 8 is introduced into the reaction chamber through an etching gas emitting ring 9 (Col. 2, lines 59-63)." Furthermore, it should be noted that the emission of these two different gases is performed at different times and thus it cannot be the same gas. One is associated with a starting gas feeding system and the other is associated with an etching gas feeding system. In *Yamakazi*, the gases are only introduced at a top region as shown by Fig. 1 and thus gases are not delivered to two different regions. See *Fujii* above. It should further be pointed out that the exiting gases are not controlled and thus they are not rationized as further required by the claim.

#### Claim 19

In contrast to *Li*, *Collins*, *Muregesh*, *Fujii*, *Fujiyama*, *Yamakazi*, claim 19 (and its dependents) specifically requires, "...said gas flow system separating and directing the flow of the same single input gas, associated with forming a plasma, at the same time into at least two different regions of said plasma processing chamber, said at least two different regions ... at least a first portion of said input gas being delivered to said upper peripheral region and a remaining

portion of said input gas being delivered to said top central region..." As mentioned by the Examiner, *Collins*, *Muregesh* do not disclose this limitation thus relying on support from the other references *Fujii*, *Fujiyama* and *Yamakazi*. These references, however, also fail to teach or suggest such a limitation (see above).

**Claim 50**

In contrast to *Li* (551), *Collins*, *Muregesh*, *Fujii*, *Fujiyama*, *Yamakazi*, claim 50 (and its dependents) specifically requires, "...a plurality of outlets arranged to deliver the same said input gas to different locations within said plasma process chamber, a first outlet being configured to deliver said input gas to said first output, a second outlet being configured to deliver said input gas to said second output, said gas flow controller directing at the same time varying amounts of said input gas to each of said first and second outputs so as to provide better process control, a first portion of the total flow of the input gas being delivered through the first outlet to the first output, and a remaining portion of the total flow of the input gas being delivered through the second outlet to the second output."

In the primary references *Li* (551), *Collins*, and *Muregesh*, different gases (NOT the same gas as required by the claim) are fed individually into different portions of the chamber. This allows an operator to deliver different mixtures into the process chamber. For example, see Col. 5, lines 14-27 in *Li* (551) where it is stated that states supplying different gases from different sources. Furthermore, as shown in the various Figures of *Collins* as for example Fig. 8, *Collins* shows seven independent gas supplies. Although the independent gas supplies may supply similar gases they do not deliver the same gas since they are independent of one another. Furthermore, *Collins* also fails to teach or suggest rationing to different regions. That is, *Collins* does not teach adjusting the amount of the input gas that is delivered to each of said first and second outputs.

Again, it should be emphasized that the present invention simultaneously feeds a single mixture to different regions of the process chamber. As a result, the same mixture is always being delivered to the different regions. The total gas flow at the inlet is equal to the sum of the gas flow at the outlets. This is simply not done in *Li* (551), *Collins*, and *Muregesh*.

*Fujii*, *Fujiyama* and *Yamaguchi* do not overcome the deficiencies of the primary references *Li*, *Collins* and *Muregesh*. In *Fujii*, the four vent pipes 111-114 are only located at the top of the reactor chamber 5 and thus gases are not delivered to two different regions. In *Fujiyama*, the gas emitting tube 4 and gas emitting ring 9 emit different gases and thus the flow of a single gas is not controlled to two different regions. In *Yamakazi*, the gases are only introduced at a top region and the exiting gases are not controlled and thus they are not rationized.

With regards to all the claims mentioned above, the remaining references of *Wing*, *Ueda*, and *Kadomura*, which are used to reject dependent claims do not overcome their deficiencies. That is, they also fail to teach or suggest the limitations of the independent claims.

In view of the foregoing, it is respectfully submitted that the rejections of all pending claims should be withdrawn.

Respectfully submitted,  
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